



Research Digest

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Research Digest

Item 1

Developing a Stabilized Public Transportation Revenue Source

ARIZONA DEPARTMENT OF TRANSPORTATION

FHWA-AZ-07-620 • 2007

The objective of this research was to explore new dedicated funding mechanisms for public transportation for the State of Arizona. The research work began with a search of the existing literature on the subject to determine what other studies had been done about this topic and what innovative financing methods had been discovered. A great deal of information was found addressing public transportation funding and unique funding methods used around the country.

Most of the research indicated that various taxes, especially motor fuel tax, provided the majority of funding for public transportation thus far. One report in particular, the Survey of State Funding for Public Transportation 2005, published by the American Association of State Highway and Transportation Officials (AASHTO), proved to be particularly informative. This report is published annually and surveys all 50 states and the District of Columbia for their public transportation funding methods. The literature review was followed by a survey that was sent to each of the 49 other state departments of transportation to further investigate the topic, determine if any programs were in use that were not included in the AASHTO survey, and if any other states had conducted studies on public transportation funding not discovered in the literature review. The survey also inquired about legislation that other states have used to secure funding for public transportation.

The survey results were disappointing with very few responses regarding innovative programs or sources of funding. However, between the survey results and her own personal search, the researchers identified 23 pieces of relevant legislation, any of which could potentially serve as a model for future Arizona legislation. It would appear that innovative funding sources across the nation are very rare and often very personalized to the state affected. However, the researchers investigated the programs and legislation provided by the survey, along with what was found by their own research, in order to provide the most comprehensive report possible based on the limited response. The population and transportation needs for the State of Arizona will continue to increase significantly into the future. Finding a dedicated revenue source is the most effective way of ensuring adequate funding for public transportation that will serve the needs of users. Researchers believe that implementation of one or more of the above potential options will lead to more revenue dedicated to public transportation for the State of Arizona.

Full-text PDF of this report is available for free download from

http://www.azdot.gov/TPD/ATRC/publications/project_reports/PDF/AZ620.pdf



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Item 2

Habitat Connectivity and Rural Context Sensitive Design within the Northern Rockies and Upper Great Plains: A Synthesis of Practice

MONTANA DEPARTMENT OF TRANSPORTATION

FHWA/MT/06-012/8117-31 • 2007

This report looks at context sensitive design/context sensitive solutions (CSD/CSS) in a rural setting relating to habitat connectivity, roadside aesthetics, and land use planning. It investigates programmatic procedures used by selected states in implementing and guiding CSD/CSS. Specifically, how can states prioritize design options in a CSD/CSS context so as to maximize the return (e.g., CSD/CSS benefits) on the limited funding for construction and maintenance? It also provides some examples of CSD/CSS design elements and specific case studies.

Full-text PDF of this report is available for free download from

http://www.mdt.mt.gov/research/docs/research_proj/habitat/final_report.pdf

Item 3

Comparative Analysis of Coarse Surfacing Aggregate Using Micro-Deval, L.A. Abrasion and Sodium Sulfate Soundness Tests

MONTANA DEPARTMENT OF TRANSPORTATION

FHWA/MT-06-016/8117-27 • 2007

Aggregates used in the construction of roads must be durable, abrasion resistant, and freeze-thaw resistant in order to perform well in pavement or as base course. The objective of this study was to investigate whether the Micro-Deval test will provide better, timelier, and more repeatable information about the quality of an aggregate than the Sodium Sulfate Soundness test. This objective was met by 1) conducting a thorough literature review, 2) testing a variety of soils from across Montana, and 3) analyzing these results to reveal potential trends.

The literature review indicated that the Micro-Deval test has good repeatability characteristics, and that it correlates well to field performance. Laboratory tests (Micro-Deval, L.A. Abrasion, and Sodium Sulfate) were conducted on a variety of soil types to examine the repeatability of each test method, and to examine how well the methods correlate with each other in terms of predicting aggregate durability and degradation. Test results were normalized to facilitate direct comparisons between the three methods. Linear regression of the data points and corresponding confidence intervals were plotted to qualitatively assess agreement or disagreement between test methods.

The authors concluded that the Micro-Deval test is a suitable replacement for the Sodium Sulfate test as the primary method for evaluating aggregate durability, with limitations. Because there were some inconsistent durability determinations between test methodologies, the authors recommend that the Micro-Deval test results be further supported by a second aggregate durability test whenever the Micro-Deval results fall between the cutoff value and plus 30% of the cutoff value. In other words, when the Micro-Deval test result for an aggregate is between 18 and 24 percent loss, a second test using an alternate method is recommended before any conclusions are made regarding the durability or quality of an aggregate.

Full-text PDF of this report is available for free download from

http://www.mdt.mt.gov/research/docs/research_proj/coarse_aggregate/final_report.pdf



Research Digest

Item 4

Wildlife-Vehicle Collision and Crossing Mitigation Measures: a Toolbox for the Montana Department of Transportation

MONTANA DEPARTMENT OF TRANSPORTATION

FHWA/MT/07-002/8117-34 • 2007

This report reviews 39 mitigation measures that reduce animal-vehicle collisions and that provide habitat connectivity for wildlife across highways. The overview is restricted to mitigation measures aimed at large terrestrial mammals (deer size and larger). However, this report also includes information regarding how such measures may affect or benefit federally endangered or threatened species in Montana, regardless of their size.

In addition to the detailed information for each mitigation measure, a summary table is provided that provides at-a-glance information on the costs and benefits of the individual mitigation measures for which such data were available. Furthermore, the report graphically illustrates which measures have the best monetary balance (the difference between benefits and costs) and which measures reduce animal-vehicle collisions and associated costs best.

Based on the results, the authors of this report identified wildlife fencing, with or without wildlife underpasses or a combination of wildlife underpasses and overpasses, and animal detection systems with wildlife fencing, as the most cost-effective mitigation measures. Animal detection systems without wildlife fences or wildlife fences with a high density of wildlife overpasses are also cost-effective, but more data on system effectiveness are needed before these systems are recommended for implementation rather than further study. The final section of the report provides suggestions on the implementation or study for each of the 39 mitigation measures. Full-text PDF of this report is available for free download from

http://www.mdt.mt.gov/research/docs/research_proj/wildlife_crossing_mitigation/final_report.pdf



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Item 5

High Fidelity Driving Simulator as a Tool for Design and Evaluation of Highway Infrastructure Upgrades

MONTANA DEPARTMENT OF TRANSPORTATION

FHWA/MT-07-005/8117-33 • 2007

A rapid prototyping approach was used in the driving simulation laboratory at the Western Transportation Institute (WTI) to simulate approximately 22 miles of US 191 between the Big Sky Resort community and the northern mouth of the Gallatin Canyon. Custom roadway tiles for the simulation were designed and programmed from The Montana Department of Transportation (MDT) "as built" plans for the highway, topographic maps, and video taken from a vehicle driving the route. The simulations may be used to help the MDT develop and refine safety countermeasures for that roadway. The primary benefit of the visualization and rapid prototyping approach using interactive, immersive simulators is that it provides an opportunity for formative evaluation, allowing engineers to refine the design at an early stage in the system development process before significant resources are invested in the deployment.

As a demonstration and evaluation of the technology, a study of driver response to speed limits posted on virtual dynamic message signs over the roadway was conducted. Such signs may be used to post speed limits that vary according to road conditions. Drivers were tested with posted speed limits of 50 MPH, 60 MPH, and in a control condition with no posted limits. There was little difference in driving behavior between drivers with no posted limits and those with a 60 MPH limit posted. Drivers with a posted 50 MPH limit reduced their speeds by approximately 6 MPH. Drivers with the 50 MPH limit also showed decreased variation in lane position (i.e., fewer and/or smaller deviations from center of lane).

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http://www.mdt.mt.gov/research/docs/research_proj/high_fidelity/final_report.pdf

Item 6

Highway Construction On-The-Job Training Program Review

MONTANA DEPARTMENT OF TRANSPORTATION

FHWA/MT-07-007/8117-28 • 2007

This study provides information about the experiences of trainees, contractors, Montana Department of Transportation (MDT) field staff, and other state DOT staff in their state's On-the-Job Training (OJT) Program. Obtaining this information is an important step in MDT's process of monitoring the quality of the OJT program, and enables MDT to report this information to the Federal Highway Administration and to the contracting community. Bureau of Business and Economic Research (BBER) at The University of Montana-Missoula administered questionnaires to individuals involved with the OJT process to gather this information.

This study consists of four parts: a survey of Montana OJT program trainees, a survey of Montana contractors who participate in the OJT program, a survey of MDT field staff who play a role in the OJT program, and key informant interviews with selected state department of transportation (DOT) staff from the western United States who are involved with their state's OJT program. Trainees in the Montana Department of Transportation's On-the-Job Training Program are generally very satisfied with the program. A majority of the contractors interviewed (55.6%) rated the quality of the OJT Program overall as good, while about one-third (33.3%) rated it fair, and only 11.1% rated it poor. Two-thirds of MDT staff (66.7%) rated the overall quality of the OJT program as good, while one-third (33.3%) rated it fair. Of the state DOT employees interviewed, most viewed the overall quality of their state's program favorably.

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Item 7

Operational Evaluation of Emissions and Fuel Use of B20 Versus Diesel Fueled Dump Trucks

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

FHWA/NC 2004-18 • 2007

Diesel vehicles contribute substantially to statewide emissions of NO_x, an ozone precursor, and to particulate matter. NCDOT is conducting a pilot study to demonstrate the use of B20 biodiesel fuel on approximately 1,000 vehicles in selected areas of the state; there are plans to extend the use of B20 fuel to a much larger number of vehicles in all 100 counties in North Carolina. Real-world in-use on-road emissions of selected heavy duty diesel vehicles, including those fueled with B20 biodiesel and petroleum diesel, were measured during normal duty cycles using a portable emissions measurement system (PEMS).

Four categories of dump trucks were selected for testing, including: (1) single rear axle with Tier 1 engines; (2) single rear axle with Tier 2 engines; (3) tandems with Tier 1 engines; and (4) tandems with Tier 2 engines. A total of 12 vehicles were tested. Each vehicle was tested for one day on B20 biodiesel and for one day on petroleum diesel, for a total of 24 days of field measurements. The vehicles were operated by drivers assigned by NCDOT. Each test was conducted over the course of an entire workshift, and on average there were 4.5 duty cycles per shift. Each duty cycle is comprised of a uniquely weighted combination of nine operating modes (idle, three levels of acceleration, three levels of cruise, deceleration, and dumping).

Average emission rates on a mass per time basis varied substantially among the operating modes. Average fuel use and emissions rates increased 26 to 35 percent when vehicles were loaded versus unloaded. Average fuel use and CO₂ emission rates were approximately the same for the two fuels, but average emission rates of NO, CO, HC, and PM decreased by 10, 11, 22, and 10 percent, respectively, for B20 biodiesel versus petroleum diesel. The average emission rates from the PEMS data were compared with engine dynamometer data.

The two data compared reasonably well and appropriately. The role of real world duty cycles, as opposed to arbitrary test cycles, was found to be critical with respect to accurate estimation of emissions, especially for NO. Factors that were responsible for the observed variability in fuel use and emissions include: operating mode, vehicle size, engine type, vehicle weight, and fuel. In some cases, the type of engine clearly had a significant role. In particular, NO and PM emission rates were typically lower for Tier 2 engines than for Tier 1 engines. Recommendations were made regarding operating strategies to reduce emissions, choice of fuel, and the need for future work to collect real world duty cycle data for other vehicle types.

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<http://www.ncdot.org/doh/preconstruct/tpb/research/download/2004-18FinalReport.pdf>



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Item 8

Stability of Calcium Sulfate Base Course in a Wet Environment

LOUISIANA DEPARTMENT OF TRANSPORTATION

LTRC 419 • 2006

Blended Calcium Sulfate (BCS) is fluorogypsum (FG), an industrial by-product, blended with lime or limestone. Approximately 90,000 metric tons (100,000 tons) of FG are generated annually in the United States, posing a serious problem for environmental disposal. The Louisiana Department of Transportation and Development (LA DOTD) has been using BCS in pavement construction over the last 15 years. While this material has performed satisfactorily after construction, its moisture sensitivity has concerned LA DOTD engineers because it has presented construction difficulty in wet environments. Therefore, there is a need to better understand the strength deterioration of BCS in a wet environment, and find ways to eliminate or reduce such deterioration by stabilizing BCS with various suitable cementitious agents.

This study was divided into two major parts: laboratory and field tests. Laboratory tests were conducted to identify factors that significantly affect the strength development of raw BCS and to seek a suitable stabilization scheme for ameliorating water susceptibility of raw BCS. The effectiveness of each stabilization scheme was evaluated from the perspective of water resistance, strength, and volumetric expansion incurred by stabilization. Laboratory tests also investigated the resilient modulus and permanent deformation characteristics of stabilized BCS. Samples tested in the laboratory included ones both molded in the laboratory and cored at the test section of the Pavement Research Facility (PRF) test site at the Louisiana Transportation Research Center (LTRC).

The field test program included two parts: (1) building a full-scale test section at the PRF site according to proposed construction specifications; and (2) evaluating the performance of stabilized BCS base courses through in-situ tests, such as DCP, FWD, and DYNAFLECT to characterize their strength and structural properties.

Ground granulated blast furnace slag (GGBFS) with a grade of 120 was used to stabilize BCS to improve its water resistance in this study. Portland cement, lime, and fly ash were also used as additives to GGBFS with different proportions to improve the properties of GGBFS-stabilized BCS.

The results from this study indicate that moisture content controlled the strength of raw BCS, although other factors such as dry unit weight also influenced the result. Curing conditions affect the strength of raw BCS through the change of moisture content in the material. The loss and regaining of strength is generally a reversible process and the presence of free water among gypsum crystal particles is the reason for this phenomenon. BCS stabilized by 10 percent 120-grade GGBFS by volume can serve as a good pavement base. It achieved a fairly higher stiffness and a structural layer coefficient of 0.30 can be used for pavement design purpose. The tentative construction specifications (Appendix A) used in the study proved to be adequate for the field construction. Therefore, it can be used with minor modification for future projects. Researchers recommend that the LA DOTD consider building several field test sections in different traffic and environmental conditions using the GGBFS-stabilized BCS as pavement base course.

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http://www.ltrc.lsu.edu/pdf/2007/fr_419.pdf



Research Digest

Item 9

Behavior and Design of Buried Concrete Pipes

NEBRASKA DEPARTMENT OF ROADS

MS 7978 • 2006

This report presents the findings of a year-long research project, where an indepth review of the available concrete pipe design methods and the Nebraska Department of Roads (NDOR) pipe design policy is conducted. In this chapter, the project's significance, objectives, and tasks are presented. Currently, two methods are available for the design of reinforced concrete pipes: the indirect design method and the direct design method. Both of the available design methods are proven to be reliable, yet as a result of recent advancements in manufacturing and construction, practical questions about the economy and state-of-the-art of the existing methods have developed.

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Research Digest

Item 10

Asphalt Materials Characterization in Support of Implementation of the Proposed Mechanistic-Empirical Pavement Design Guide

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 07-CR10 • 2007

The proposed Mechanistic-Empirical Pavement Design Guide (MEPDG) procedure is an improved methodology for pavement design and evaluation of paving materials. Since this new procedure depends heavily on the characterization of the fundamental engineering properties of paving materials, a thorough material characterization of mixes used in Virginia is needed to use the MEPDG to design new and rehabilitated flexible pavements.

The primary objective of this project was to perform a full hot-mix asphalt (HMA) characterization in accordance with the procedure established by the proposed MEPDG to support its implementation in Virginia. This objective was achieved by testing a sample of surface, intermediate, and base mixes. The project examined the dynamic modulus, the main HMA material property required by the MEPDG, as well as creep compliance and tensile strength, which are needed to predict thermal cracking. In addition, resilient modulus tests, which are not required by the MEPDG, were also performed on the different mixes to investigate possible correlations between this test and the dynamic modulus.

Loose samples for 11 mixes (4 base, 4 intermediate, and 3 surface mixes) were collected from different plants across Virginia. Representative samples underwent testing for maximum theoretical specific gravity, asphalt content using the ignition oven method, and gradation of the reclaimed aggregate. Specimens for the various tests were then prepared using the Superpave gyratory compactor with a target voids in total mix (VTM) of 7% \pm 1% (after coring and/or cutting).

The investigation confirmed that the dynamic modulus test is an effective test for determining the mechanical behavior of HMA at different temperatures and loading frequencies. The test results showed that the dynamic modulus is sensitive to the mix constituents (aggregate type, asphalt content, percentage of recycled asphalt pavement, etc.) and that even mixes of the same type (SM-9.5A, IM-19.0A, and BM 25.0) had different measured dynamic modulus values because they had different constituents. The level 2 dynamic modulus prediction equation reasonably estimated the measured dynamic modulus; however, it did not capture some of the differences between the mixes captured by the measured data. Unfortunately, the indirect tension strength and creep tests needed for the low-temperature cracking model did not produce very repeatable results; this could be due to the type of extensometers used for the test.

Based on the results of the investigation, it is recommended that the Virginia Department of Transportation use level 1 input data to characterize the dynamic modulus of the HMA for projects of significant impact. The dynamic modulus test is easy to perform and gives a full characterization of the asphalt mixture. Level 2 data (based on the default prediction equation) could be used for smaller projects pending further investigation of the revised prediction equation incorporated in the new MEPDG software/guide. In addition, a sensitivity analysis is recommended to quantify the effect of changing the dynamic modulus on the asphalt pavement design. Since low-temperature cracking is not a widespread problem in Virginia, use of level 2 or 3 indirect tensile creep and strength data is recommended at this stage.

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Research Digest

Item 11

Identification of Potential Fee Structures for Land Development Reviews by the Virginia Department of Transportation

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 07-R20 • 2007

This report describes an effort to determine the costs incurred by the Virginia Department of Transportation (VDOT) when reviewing land development proposals, such as traffic impact studies, comprehensive plan amendments, rezonings, and subdivision and site plans. Cost estimates were derived from a survey of land development staff from VDOT's districts and residencies who perform the reviews on a regular basis.

The VDOT reviewers who participated in the survey were shown actual land development proposals taken from the archives of VDOT's Culpeper District Office and asked to provide an estimate of how long it would take to review each proposal. The resulting estimates suggest that a review of even a relatively simple land development proposal will cost more than \$1,000, which at the time of this writing is the statutory fee cap.

The report, therefore, recommends that \$1,000 be used as the fee for review of a land development proposal. The report also recommends that additional studies be conducted to develop a fee schedule that is fair and easy to administer and that recovers most of the costs VDOT incurs in performing reviews of land development proposals.

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Research Digest

Item 12

Implementation of an Automated Test Setup for Measuring Electrical Conductance of Concrete

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 07-R21 • 2007

This project was designed to provide the Virginia Department of Transportation (VDOT) with an automated laboratory setup for performing the rapid chloride permeability test (RCPT) to measure the electrical conductance of concrete in accordance with applicable standards. As an increasing number of construction projects is becoming subject to concrete permeability acceptance testing, there is a growing need for conducting laboratory RCPT in a timely and expedient manner. Typically, concrete cylinders arrive at VDOT's materials laboratory in large batches, sometimes more than 100 units at a time. This often results in backlogs in processing and leads to considerable delays. The lack of commercially available test equipment created a need to develop an automated device that could expedite large scale production testing. The Virginia Transportation Research Council was contacted to provide technical assistance. This report describes the practical implementation of a workable RCPT device.

An automated laboratory setup for conducting RCPTs was developed and implemented at VDOT. The microprocessor-controlled device is capable of unattended measurement and monitoring of up to 32 concrete specimens at a time in accordance with AASHTO and ASTM test methods. The device is based on the Campbell Scientific CR10X Datalogger interfaced with the Campbell Scientific AM16/32 Multiplexer. Date- and time-stamped test records are stored electronically in ASCII format.

As there are no commercially available devices with a comparable function, it is difficult to assess the initial cost of development and setup. There are, however, substantial cost savings associated with the operation of this device. It is estimated that the resultant savings are equivalent to the costs of one full-time technician position in VDOT's materials laboratory. These costs are approximately \$46,000 per year, accounting for salary and benefits.

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Research Digest

Item 13

Installation of Warm Mix Asphalt Projects in Virginia

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 07-R25 • 2007

Several processes have been developed to reduce the mixing and compaction temperatures of hot mix asphalt (HMA) without sacrificing the quality of the resulting pavement. The purpose of this study was to evaluate the installation of warm mix asphalt (WMA) to compile experiences and offer recommendations for future use. Three trial sections were installed using warm mix technologies between August and November of 2006. Two used the Sasobit technology, and the third employed the Evotherm technology. This report discusses the material makeup of these technologies and documents the production and placement of the three trial sections. The results of this study and further studies can serve as a basis for decision making by the Virginia Department of Transportation (VDOT) regarding the use of WMA technology.

Trial sections were initiated through cooperative efforts by the Virginia Transportation Research Council; VDOT districts, residencies, and area headquarters; and participating contractors. Construction used typical mixture designs and practices so that performance under typical construction conditions could be evaluated. General experiences and processes used during construction were documented, and samples were taken for laboratory characterization. Density measurements and cores were taken at each site to determine the initial pavement properties. At the Evotherm installation, asphalt fume sampling was conducted by VDOT's Employee Safety & Health Division to evaluate differences in worker exposure between HMA and WMA pavement laydown operations.

The study showed that WMA can be successfully placed using conventional HMA paving practices and procedures with only minor modifications to account for the reduction in temperature. The evaluated technologies affected mixture properties in slightly different ways such as changes in tensile strength ratios and variability in air voids. Additional monitoring of constructed sections was recommended to evaluate long-term performance.

Inclusion of WMA technology as an option for paving operations provides potential benefits to VDOT and the contracting community. Theoretically, these technologies could extend the asphalt paving season into cooler weather, allowing for better optimization of paving resources. The technologies also allow the construction of asphalt pavements at lower temperatures, resulting in reduced cooling time before the pavement is opened to traffic. Lower production temperatures may also increase mixture durability by reducing production aging of the mix. Benefits to contractors may include the ability to increase hauling distances between the plant and project, reduced plant emissions resulting in improved air quality, and cost savings because of reduced energy costs. Because of the experimental nature of this study, no cost savings data are yet available to justify or refute the use of WMA technologies.

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Research Digest

Item 14

The Next Step Toward End-Result Specifications for Hot-Mix Asphalt Materials and Construction

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 07-R26 • 2007

In 2000, the Virginia Department of Transportation's (VDOT) Chief Engineer asked the Virginia Transportation Research Council to develop a vision of how and when VDOT would have a working end-result specification for hot-mix asphalt. The response to that question was that it would take several years and many steps to achieve. This report discusses the next step in that ongoing effort, which includes the development and simulated application of two statistical quality assurance (SQA) special provisions, one for asphalt concrete material and the other for asphalt concrete pavement. The criteria for these prototype SQA provisions included the application of standard national terminology and approach, a firm basis in existing VDOT specifications, and quality characteristics that represent the best practical performance measures.

This report describes the outcome of a "shadow" application of the proposed SQA specifications to a subset of Virginia's annual maintenance-resurfacing projects. Although the involved production and placement activities were not subject to the requirements of the SQA specifications, the sampling and testing were designed to represent what would have been required had the special provisions been in effect. The study further determined the likely acceptance outcome for each shadow project and explored future modifications to specification limits and pay adjustment criteria.

The most desirable benefit from effective end-result specifications stems from the ability to rededicate available inspection to those key production and placement processes (e.g., joint tacking and surface preparation) that cannot be measured upon delivery to the owner/agency. A less desirable, but more tangible, financial benefit results when these specifications permit a reduction in the overall inspection force. One conservative estimate suggests that VDOT could save more than \$2 million per year in inspector salaries through an end-result specification for acceptance of hot-mix asphalt pavements.

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Item 15

Use of the Micro-Deval Test for Assessing the Durability of Virginia Aggregates

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

VTRC 07-R29 • 2007

Aggregate is one of the most widely used construction material, and the key aspect of aggregate quality is durability. In this study, the Micro-Deval test, a new test developed in France and modified by Canadians, was studied to evaluate its suitability in assessing the durability of coarse and fine aggregates from Virginia sources. The Micro-Deval and several known aggregate tests were compared. The Micro-Deval test showed a very high potential in evaluating aggregate durability with higher precision and accuracy than the conventional tests such as the magnesium sulfate and Los Angeles abrasion tests. The Micro-Deval test was able to differentiate between good and poor performing aggregates at least 70 percent of the time and was able to identify the quality difference between similar aggregate types with varying degrees of weathering. Because of the study findings, the researchers recommend that the Micro-Deval test be used as a quality control tool for aggregate assessment to supplement the current measures of aggregate quality.

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Research Digest

Item 16

Improving Dual-Loop Truck (and Speed) Data: Quick Detection of Malfunctioning Loops and Calculation of Required Adjustments

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

WA-RD 647.1 • 2007

The capability of measuring vehicle lengths makes dual-loop detectors a potential real-time truck data source for freight movement studies. However, a previous study found that the dual-loop detection system of the Washington State Department of Transportation (WSDOT) was not consistently reporting accurate truck volumes because of its sensitivity setting problems. Specifically, the sensitivity problems found were: (1) sensitivity discrepancies between the two single loops that form a dual-loop detector; and (2) unsuitable sensitivity level settings for both single loops even when discrepancies weren't significant. Both problems can result in erroneous vehicle length estimates and, consequently, inaccurate truck counts.

As an extension of the previous study, this research project developed an algorithm for the identification and correction of such loop sensitivity problems. The algorithm identifies dual-loop sensitivity problems using individual vehicle information extracted from high-resolution loop event data and corrects dual-loop sensitivities through a two-step procedure: 1) remove the sensitivity discrepancy between the two single loops and 2) adjust their sensitivities to the appropriate level. The algorithm was also implemented in a computer application named the Advanced Loop Event Data Analyzer (ALED) system for convenient usage.

Elimination of dual-loop sensitivity problems enhances the reliability of the dual-loop detection system and improves the quality of truck volume data. The findings and products from this study will help WSDOT obtain more accurate speed and truck volume data from the existing dual-loop detectors.

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Research Digest

Item 17

Homeless Student Transportation Project Evaluation

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

WA-RD 665.1 • 2006

Washington State funded pilot homeless student transportation programs from 2004-2006 to implement provisions of the McKinney-Vento Homeless Education Assistance Act (2001). The Act requires school districts to provide transportation to homeless students wishing to remain in their school of origin. This formative evaluation addressed four questions about those pilot efforts: (1) what modes of transportation were used; (2) what did they cost; (3) which were preferred; and (4) did staying in the school of origin affect students' academic performance? The study analyzed ridership and cost data from eight educational service districts and interviewed homeless students, parents, transportation coordinators, and homeless liaisons. Findings include the following:

Districts used a wide array of methods to transport students, employing school buses, public transit, vans, taxis, private vehicles, fuel vouchers, mileage reimbursement, and transportation brokerage systems. School buses provided 38 percent of the trips, followed by third-party brokered transportation (cars, taxis, and vans) at 28 percent, and public transit at 22 percent.

Homeless student transportation was usually expensive. The cost to the school districts of one-way homeless student trips varied widely depending on locality and mode, from a low of \$0.14 to a high of \$54. Public bus service was the least costly mode; however, it was used mostly for older students and only available in selected areas. The cost for providing homeless students with public bus service ranged from \$ 0.14 to \$1.00 per one-way trip. By comparison, the cost for providing homeless students a one-way trip via school bus ranged from \$4.50 to \$54. (The average cost for a one-way school bus trip for the general student population is about \$0.67.)

Staying in one's school of origin was associated with better Washington Assessment of Student Learning (WASL) scores. In our limited data set, homeless students had lower grade point averages and lower WASL scores than the general student population. However, among homeless students, those staying in their school of origin achieved better WASL scores and better high school grades than those who changed schools.

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Research Digest

Item 18

Improving Predictions for Camber in Precast, Prestressed Concrete Bridge Girders

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

WA-RD 669.1 • 2007

This research was conducted to develop improved methods of predicting camber in prestressed concrete girders. A computer program was written to calculate camber as a function of time. It takes into account instantaneous and time-dependent behavior of the concrete and steel and performs the calculations in a series of time steps. It was calibrated by comparing its predictions with the camber from 146 girders, measured in the fabricators yard both after release and at a later time. Its long-term predictions were then compared with the responses of 91 girders that were monitored during construction at the Keys Road Bridge site.

The results showed that the response was sensitive to the predicted prestress losses, and that the 2006 AASHTO values for prestress loss provided much better estimates than did the 2004 provisions. In addition, the camber was found to depend on the elastic modulus of the concrete, its creep coefficient, and the use of the prestress losses in the calculation of the creep camber. To achieve the best match with the measured cambers, the AASHTO-recommended values for the elastic modulus and the creep coefficient had to be multiplied by adjustment factors and the prestress losses had to be taken into account when computing the creep component of camber.

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Research Digest

Item 19

Managing Pedestrian Safety I: Injury Severity

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

WA-RD 671.1 • 2007

This study focused on the severity of injuries and fatalities incurred by pedestrians colliding with motor vehicles. The report includes a thorough review of the literature and a description of new research carried out on correlates of injury severity and measures of their relative effects on fatal or high injury collisions. The correlates consisted of both individual-level factors and attributes of environments at or near pedestrian collision sites.

The study focused on state routes in King County, Washington. Data came from police records processed by the Washington State Department of Transportation (WSDOT) from 1999 to 2004. They included objective and modeled data in GIS on road characteristics, traffic conditions, and land uses at or near collision sites.

The results of binary and ordinal logistic models showed that fatal and high injury collisions were strongly and significantly associated with (1) a pedestrian crossing at an unsignalized intersection (versus crossing at all other locations or walking along the roadway); (2) the vehicle moving straight ahead on the roadway (versus all other types of vehicle actions). There was a lack of association between injury severity and collision frequency, suggesting that safety programs intended to reduce the number of collisions and those intended to reduce the risk of severe injury and death should use different approaches. The latter should focus on individual factors such as driver or pedestrian actions and behaviors, as well as on road environment factors such as speed limits and intersection signalization. Finally, better reports and data on vehicular speed at the time of collision, and on the type of vehicles involved in pedestrian collisions, would help to inform effective future safety programs, policies, and standards.

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Item 20

ITS Backbone

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

WA-RD 676.1 • 2007

In this brief report, we provide a description of the activities in each of the areas to which the Backbone contributes, and we provide supporting statistics for each of these contributions. The form of these statistics varies by application area: (1) potential viewers, in the case of TrafficTV, (2) page views, in the case of MyBus, (3) data stream use, in the case of Busview, (4) number of downloads, in the case of the Self Describing Data (SDD) Toolkit and, (5) use of the Web services.

The ITS Backbone has been financially supported by WSDOT to provide a level playing field to distribute detailed real-time and historical data to the public, private, and research sectors.

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